Addendum No. 2

RANGER BLOCK III
LAUNCH CONSTRAINTS
PLANNING DOCUMENT
(EPD-130)

JET PROPULSION LABORATORY
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA

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RANGER BLOCK III
LAUNCH CONSTRAINTS
PLANNING DOCUMENT
(EPD-130)

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FOREWORD

Revisions to this Addendum will be issued daily at AMR during the launch period. These revisions, rather than this Addendum, will be the controlling editions of EPD 130 for use during the launch operations.

I. INTRODUCTION

Addendum No. 2 to EPD 130 (Reference 1), "Ranger Block III Launch Constraints Document", is a dual purpose document that: (1) up-dates EPD 130 and (2) presents the detailed launch constraints for each day of the launch period. It is to be used in conjunction with EPD 130 for the third launch period (January 30 to February 6, 1964).

The Addendum adheres to the same general ground rule on which EPD 130 is based; namely, that the spacecraft/launch vehicle system is functioning properly and consequently, consideration is not given to launch constraints that result from system failures. Thus, only launch constraints resulting from exceeding the design limits or man-made policy limits on the system were considered.

It must be emphasized that this Addendum does not necessarily present the final detailed daily launch constraints. Specifically, the final controlling launch constraint plans will be issued at AMR on a daily basis during the launch period. However, the Addendum should be considered as the current best estimate of the launch constraints.

The criteria for hold which govern the evaluation of nonstandard operation of the spacecraft and launch vehicle systems are published in Reference 2 and Reference 3 for each system, respectively. These documents and this Addendum constitute a handbook for establishing a go or no-go launch decision during the countdown.

II. UPDATED LAUNCH CONSTRAINTS

It is the intent in this Section to update the launch constraints presented in Part II and Appendix D of EPD 130. Those constraints which are not revised in this Addendum are to be assumed valid as stated in EPD 130.

A. Range Safety

1. Permissible Launch Azimuth Corridor

AMR has reviewed the Ranger Block III Launch Azimuth Sector Waiver Request. As a result of this review the Ranger Project has been granted permission to launch within the azimuth corridor between 90 and 114 degrees.

2. Agena Command Destruct

An independent command destruct system will be carried aboard the Agena vehicle.

B. Launch Vehicle

1. Agena Restart Timer

The Agena restart timer enables the launch vehicle system to accommodate the required variation in parking-orbit coast time necessary to support the Ranger lunar mission profiles. The actual component that provides this variation is the Agena patch plug which permits a parking-orbit coast time variation of 540 seconds. This limitation, combined with the hardware restriction limiting the employment of four (4) plugs to each launch period, established the basis for the timer constraint on launch window design. The window design is summarized in Figure 1.

2. Agena Horizon Sensor

a. Sun-in-the-Field-of-View

The Agena horizon sensors do not function properly when the Sun is in the field of view of the sensor. However, a Sun-sensing device has been incorporated to inhibit the horizon sensor when the Sun is in the field of view. Tests that have been conducted on this system indicate that it performs satisfactorily. This device is enabled after Agena first-burn cutoff and would not solve a Sun problem during Agena first burn. However, the Sun-in-the-field-of-view problem does not exist during the first burn for the February launch period.

b. Cold Clouds

The horizon sensors respond improperly to cloud masses within their field of view. LMSC has developed procedures whereby this potential problem can be evaluated prior to launch. A launch constraint resulting from this problem is not predictable this far in advance of the launch.

3. Weather Conditions

Adverse weather conditions can result in a launch hold. These conditions are discussed briefly below.

a. Winds

Excessive surface winds and/or excessive wind shear can result in a launch hold. These conditions are documented in Reference 3.

b. Clouds and Precipitation

Excessive clouds in the line-of-sight path from the Cape to the Atlas can cause excessive attenuation of the GE guidance signal. Excessive rain has the same effect. There is also maximum tolerable precipitation at the launch site, as well as minimum ceilings. These considerations are also discussed in detail in Reference 3.

4. LOX Topping

Studies performed by the Fields Project Branch of Goddard has established that the maximum acceptable LOX topping time is three (3) hours. Since this time limitation is in excess of any possible launch window duration for the February launch period, it does not impose any launch constraints.

There exist, however, other potential launch constraints associated with the launch vehicle which have not, to date, been defined. For example, the critical Atlas cold-soak time has not been established, but it is expected to be less than three (3) hours.

C. AMR and JPL Launch Operations Constraints

No constraints to the launch are expected in this area.

D. JPL Flight Operations Facility Launch Constraints

No constraints to the launch are expected in this area.

E. Tracking and Telemetry Coverage Launch Constraints

This discussion is a brief review of the major deficiencies in coverage. The detailed discussions are contained in Part III.

1. AMR Uprange Support

The uprange tracking and telemetry coverage will satisfy the Class I requirements placed on the range. The previous tracking problem that existed primarily because of low-elevation angle coverage from Antigua for launch azimuths between 90 and 93 degrees has been eliminated. This has been accomplished by the committed application of the Bermuda radar for Ranger 6. The available uprange coverage capabilities are presented in Figure 2.

2. AMR Downrange Support

AMR support of the Class I tracking requirement for 60 seconds of post-second burn tracking prior to Agena retro maneuver is complete for all days on all flight azimuths.

AMR support of the Class I requirements for coverage of Agena telemetry during second burn and during Agena-spacecraft separation is also virtually complete on all days. However, coverage on January 30 is not committed during the ignition phase for launch azimuths between 98 and 102 degrees.

AMR support of the Class I requirement for coverage of the spacecraft at L-band from Agena-spacecraft separation minus 10 seconds to Agena-spacecraft separation plus two (2) minutes is limited. Coverage cannot be committed for any flight azimuth the last day of the launch period. On the other six (6) days the windows are about one (1) to 1 1/2-hours in duration, instead of the 2-3 hours otherwise available.

The major reasons for this deficiency are the slant range power limitations of the Yankee and Twin Falls Victory Ships. The Yankee is power limited during the parking orbit. The Twin Falls Victory becomes power limited rather than horizon limited shortly after injection when the spacecraft is rising in altitude. Continuous coverage at L-Band by the range and/or DSIF begins within two (2) minutes after separation throughout most of the launch windows. Also, coverage at L-band prior to separation exists in many cases.

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In fact, for some uprange injections, complete coverage by AMR is provided from launch to continuous DSIF view.

3. DSIF Support

a. Tracking Coverage

The Class I (mandatory) requirement for a maneuver capability over Goldstone can be met on all days.[1] This requirement also can be met on all days with Johannesburg or MTS data alone. In a few cases, Woomera data are sufficient, and in some additional cases, Woomera and Goldstone data are adequate.

The Class II (desirable) requirement for a maneuver capability over Johannesburg also can be satisfied on all days. In fact, this requirement can be met using only Johannesburg or MTS data. Again, in a few cases, Woomera data are sufficient.

b. Telemetry Support

The DSIF must provide continuous telemetry coverage early in the flight, beginning two (2) minutes after the time continuous DSIF view begins. In order to comply with this requirement, Woomera, Johannesburg/MTS, and Goldstone are needed during some portions of the launch windows. During other times, however, Johannesburg/MTS and Goldstone can completely provide the coverage.

Refer to Part III for a detailed discussion on a daily basis and Part IV for the procedure for an analysis of a typical launch day.

[1] See Reference 1, Table B-1, Part I.

III. LAUNCH WINDOW DESIGNS

An analysis of the launch constraints pertinent to the February launch period has definitized the launch window designs presented in Figure 1 on a daily basis. Figure 1 shows the permissible launch azimuths and additionally, the available launch window duration in minutes. The azimuth sectors that had to be eliminated from the launch window and the constraint that was responsible for their elimination are indicated.

These launch window designs are based upon the coverage provided by the ships located as listed in Table I. Any changes in the ship locations must be properly translated into changes in coverage and, hence, changes in the launch window design. The coverage support by AMR was based on the committed coverage in Reference 4.

Should the launch window design be subsequently revised, a plot of launch azimuth versus launch window duration is presented in Figure 3 which permits a rapid estimate of the new launch window duration as a result of the revision.

The station view periods, the Class I tracking and telemetry requirements, and the available coverage capabilities are visually depicted for each launch day in Figures 4 through 17. These illustrations have been arranged in pairs facing each other for a given launch day as a convenient cross-reference.

The illustration of the Class I tracking and telemetry coverage requirements and available capabilities to satisfy these requirements are provided by Earth-track maps and overlays presented in Figures 5, 7, 9, 11, 13, 15, and 17. The permissible launch corridor is formed by the launch azimuths of 90 and 114 degrees as determined by range safety. In constructing the coverage patterns on the map itself, it was assumed that all the land stations and the ships have view periods beginning and ending at zero (0) degree elevation. In practice, however, many of the view periods would be limited to elevation angles above 2 to 3 degrees as a result of lock-up time considerations, atmospheric refraction, range (power) limitations, etc. The overlays for each map show the approximate telemetry coverage capability of those stations that are limited in their coverage by slant range power limitations. These coverage estimates are, of course, approximate and change significantly as the telemetry station-vehicle geometry changes. For example, the antenna pattern nulls cause the slant range power limitation to vary. However, these factors were properly

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reflected in the review of the launch window (Figure 1) through the utilization of only committed AMR and DSIF coverage patterns. In addition to showing the coverage available, the Class I tracking and telemetry coverage requirements for both the launch vehicle and the spacecraft are displayed in these illustrations.

The station view periods as a function of time from launch and launch azimuth presented in Figures 4, 6, 8, 10, 12, 14, and 16 indicate the available coverage on a time basis for all stations and for all possible launch azimuths. The important events such as second burn, separation, etc., are included. Elevation angle constraint of zero (0) degrees was again applied in the creation of these illustrations so that when they are used in conjunction with the Earth tracks, a consistent picture is presented of the coverage requirements and capabilities both as a function of position and time.

Table II, prepared for a launch attempt on January 30, 1964, shows the percent coverage furnished by each station in support of the Class I coverage requirements. Similar tables will be prepared for all launch days on a daily basis during the launch period. These coverage estimates were based on AMR committed coverage in Reference 4. Table II is useful in that it allows the user to rapidly find the stations that are providing the necessary coverage of key events and the existing coverage redundancy. It will be noted that in some of the instances when the coverage is less than 100% the letters "b" or "e" follow the percentage. These letters indicate whether the coverage occurs at the beginning (b) or the end (e) of the event. Since in some cases it is possible to have no single station providing 100% of the required coverage of an event at a given azimuth, the (b) and (e) indicate whether or not the combined station coverage of the key event is complete.

Table II also provides information on which stations are mandatory for launch. It is easy to see that whether or not a station is providing mandatory coverage is dependent both on launch day and on the particular trajectory (launch plan) in question.

It is not possible in this Addendum to analyze in sufficient detail which stations are mandatory on a day-by-day, launch-plan-by-launch-plan basis. Rather, this detailed analysis will be presented in the revisions to this Addendum that will be issued daily during the launch period.

IV. PROCEDURE FOR THE ANALYSIS OF A TYPICAL LAUNCH DAY

Delineated in this section is the procedure for utilization of the tables and illustrations. January 30 was selected as the sample day for analysis and for illustrating the procedure.

By referring to Table I, it can be seen that two ships are available on January 30. One is the Twin Falls Victory (TFV) scheduled to be located at latitude 4°16'N and longitude 27°20'W. The other is the Yankee to be located at a latitude of 8°30'S and a longitude of 5°30'E.

The TFV provides launch vehicle tracking and launch vehicle and spacecraft (L-band) telemetry. The Yankee provides launch vehicle and spacecraft (L-band) telemetry only.

These ships along with their projected coverage capability are shown on the Earth-track map (Figure 5) at the locations specified for the day of January 30. An examination of the coverage provided by the combination of land and ship stations in this illustration will indicate the total coverage available. As a result of Agena timer constraints described in Part II, approximately the first one-half (1/2) degree of the launch corridor is eliminated. The Class I requirements for tracking and telemetry are indicated by the shaded areas and defined by the key in the upper right-hand corner. Reiterating the ground rule stated in Part II (namely, that the coverage curves are for zero (0) degree elevation angles, also appearing as Note 1. on each Earth-track illustration), it can be seen that even with this theoretical limit, Class I spacecraft telemetry coverage (L-band) is lacking near a launch azimuth of 102 degrees. Yankee is not useful in this case because of its very limited L-band range capabilities, and Ascension and Johannesburg cannot, by themselves, satisfy these requirements. When the practical limitations are imposed upon the coverage capabilities (that is, coverage shown on the overlays), the coverage is correspondingly decreased. As a result, a relatively large portion of the launch window becomes unacceptable. AMR defined these portions by launch azimuth and they are so presented in Figure 1. The acceptable launch window duration was obtained from Figure 3 by entering with the appropriate launch azimuths. Thus from Figure 1, it can be seen that the acceptable launch window is divided into two parts. The first part extending from a launch azimuth of 90.5 to 96.5 degrees provides a launch duration of 51 minutes. In addition, 45 minutes is available in the second acceptable portion from 107 to 114 degrees.

The approximate coverage intervals of the tracking and telemetry stations based on time from liftoff are supplied from Figure 4.

Part III includes a description of the percent coverage presented in Table II. This tabulation was constructed by examining the coverage available to meet the Class I tracking and telemetry requirements along constant azimuth lines on the Earth-track map (Figure 5). In order to present the situation most realistically, the AMR coverage capability used to construct Table II was based on AMR coverage commitments in Reference 4. The extent to which each tracking and telemetry station covers the Class I requirements is obtained by reading across Table II for any particular launch azimuth.

Table II shows that the permissible launch plans for January 30 are numbers 30A through 30F and 30O through 30R.

Again, it is pointed out that this analysis is included in this Addendum for information only. The controlling launch plans will be issued on a daily basis during the launch period.

REFERENCES

1. EPD-130, "Ranger Block III Launch Constraints Planning Document", 26 July 1963.

2. JPL TOP 3R 001.00, "Test and Operations Plan (TOP)", November 25, 1963.

3. LMSC 271739 "Atlas/Agena Working Group Launch Test Directive, Ranger Block III", November 22, 1963.

4. PAA letter dated 24 December 1963; Log. No. 4110B-337; Subject: AMR Instrumentation Coverage Plan - Ranger 6.

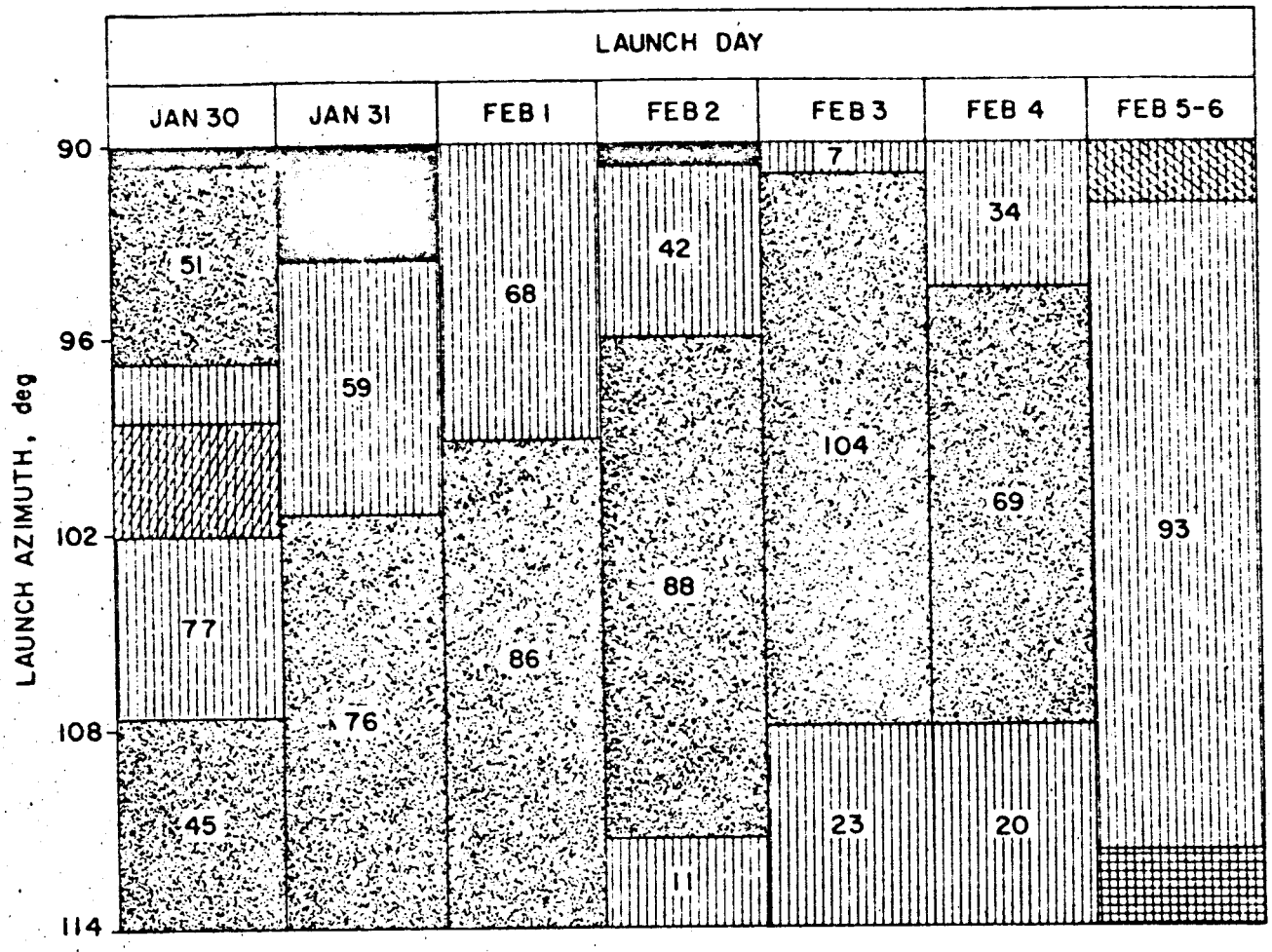
Table I. Tracking and telemetry ship locations

Day	Station	Latitude	Longitude
Jan. 30	TFV	4°16'N	27°30'W
	Yankee	8°30'S	5°30'E
Jan. 31	TFV	4°16'N	27°20'W
	Yankee	7° 0'S	2°30'E
Feb. 1	TFV	5°25'N	24° 0'W
	Yankee	5° 0'S	0° 0'
	Whiskey	8° 0'N	37°30'W
Feb. 2	TFV	5°25'N	24° 0'W
	Yankee	2°30'S	2° 0'W
	Whiskey	9°30'N	40°30'W
Feb. 3	TFV	7° 0'N	28°25'W
	Yankee	0°30'S	4°30'W
	Whiskey	11°30'N	43° 0'W
Feb. 4	TFV	9°50'N	32°40'W
	Yankee	2°30'S	2° 0'W
	Whiskey	14° 0'N	45° 0'W
Feb. 5-6	TFV	12°10'N	37° 0'W
	Yankee	5° 0'S	0° 0'
	Whiskey	16° 0'N	47°30'W

/C

Table II. Available tracking and telemetry coverage by station and event for January 30, 1964

Plan No.	Booster roll azimuth (deg)	Any 60 seconds postinjection tracking			Agena telemetry second burn			Two (2) minutes S/C TM beginning at Agena-S/C separation				Agena TM at Agena-S/C separation			Stations required for continuous S/C TM Post-Agena-S/C separation	Notes
		TFV	12	13	TFV	12	Yankee	12	Yankee	13	51/59	12	Yankee	13		
30A	90.6	0%	0%	100%	0%	0%	100%	0%	0%	100%	70%(c)	0%	0%	100%	51/39, 41	1) Coverage estimates are based, in part, on AMR committed coverage
30B	91.6										60%					
30C	92.7										50%					2) DSIF two (2) minute lockup time was assumed
30D	93.8										40%		100%			
30E	95.0										30%					3) AMR committed coverage indicated the lack of S/C TM coverage immediately following separation from a launch azimuth of 96.5 to 107 degrees as shown in the Summary Chart in Figure 1
30F	96.2					0%				100%	20%					
30G	97.4					30%(b)				90%	10%					
30H	98.7					70%	100%			90%(c)	0%			0%		
30I	100.0		0%			100%	85%(c)			80%						4) (b) Denotes partial coverage including beginning of the required coverage interval.
30J	101.3		25%				60%			70%						
30K	102.7		100%				30%			60%						
30L	104.1				0%		10%	0%		50%						5) (c) Denotes partial coverage including end of the required coverage interval.
30M	105.4				15%(b)		0%	30%(b)		40%		100%				
30N	106.9				30%			70%		30%					12, 51/39, 41	
30O	108.5				60%			100%		20%						
30P	110.0				70%					10%						
30Q	111.6				80%	100%				0%						
30R	112.9				90%	80%										



NOTES:

1. COVERAGE ESTIMATES ARE BASED AMR COMMITMENTS IN REFERENCE 4
2. SHIP LOCATIONS ARE LISTED IN TABLE I
3. COVERAGE OF POST-INJECTION TRACKING IS ADEQUATE
4. COVERAGE OF *AGENA* SECOND BURN (BURNOUT) IS ADEQUATE
5. THIS CHART DOES NOT CONSIDER POSSIBLE CONSTRAINTS TO THE LAUNCH WINDOWS DUE TO MAXIMUM ATLAS LOX TOPPING TIME, MAXIMUM ATLAS COLD SOAK TIME, ETC. THESE CONSTRAINTS ARE DISCUSSED IN PART II
6. THERE ARE NO CONSTRAINTS DUE TO INADEQUATE DSIF TRACKING

Fig. 1. Ranger launch window designs for February launch period

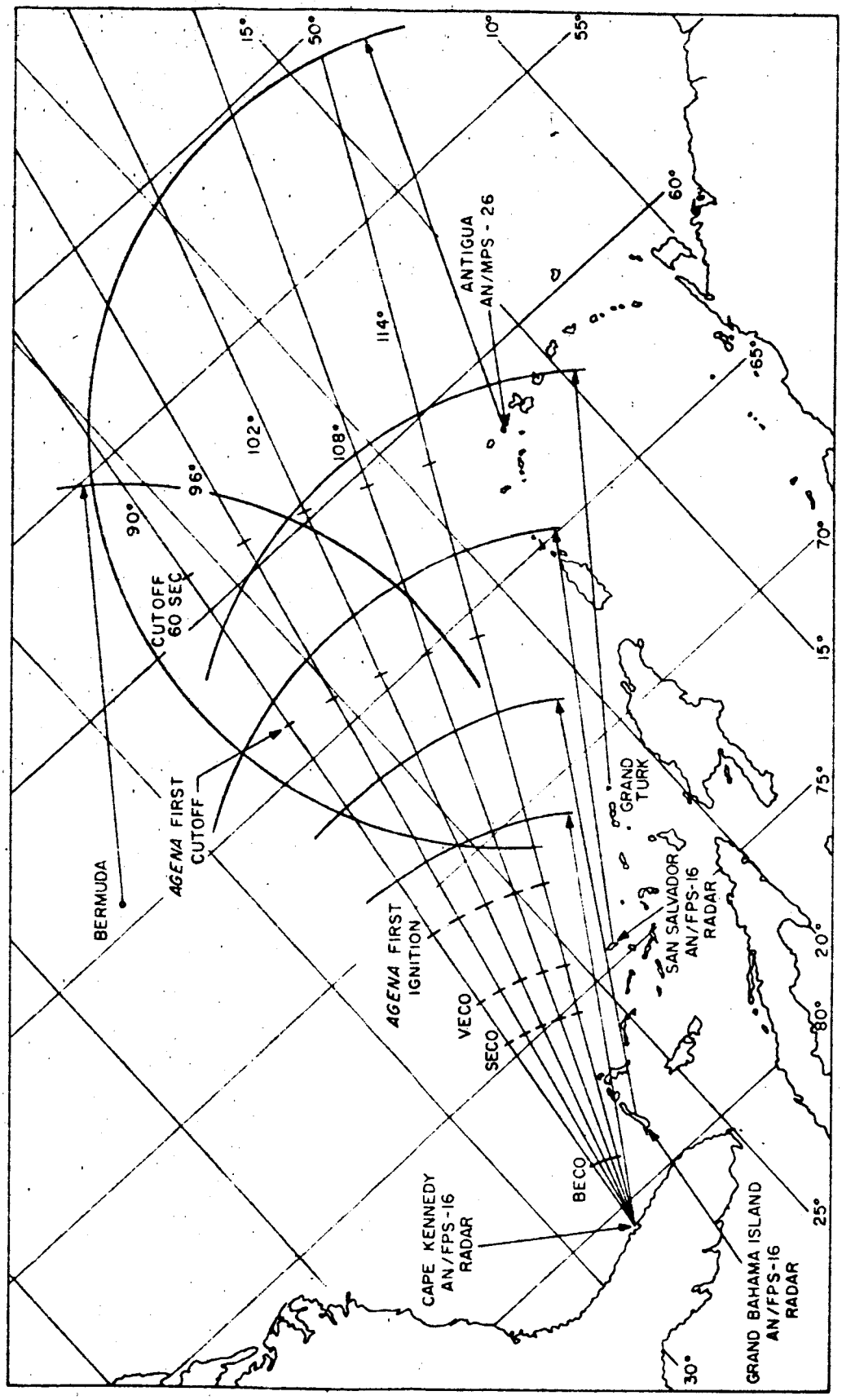


Fig. 2. Ranger uprange radar coverage

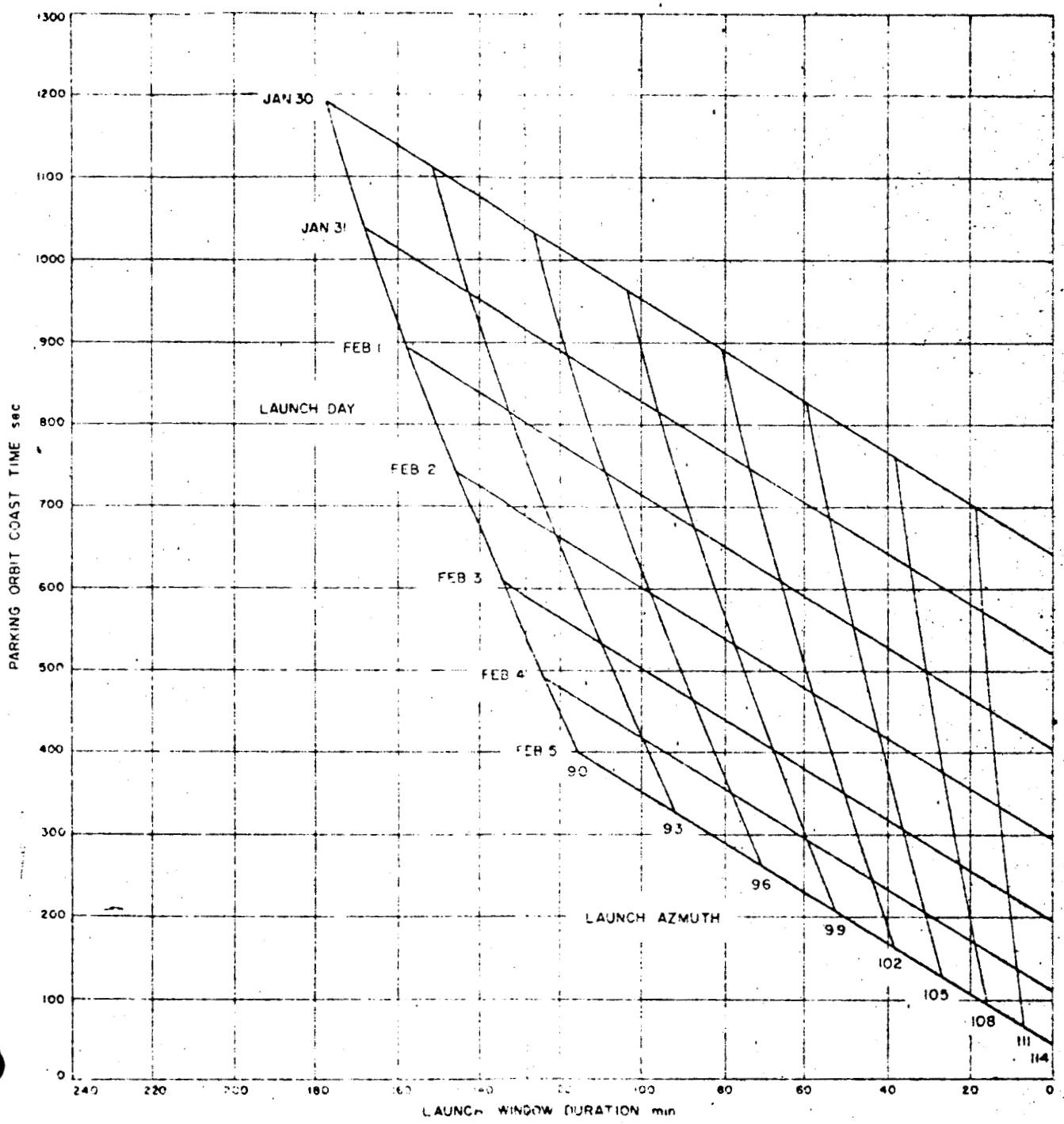


Fig. 1. Atlas-Agena-Ranger orbit coast time versus launch window Duration for February 1964 launch period

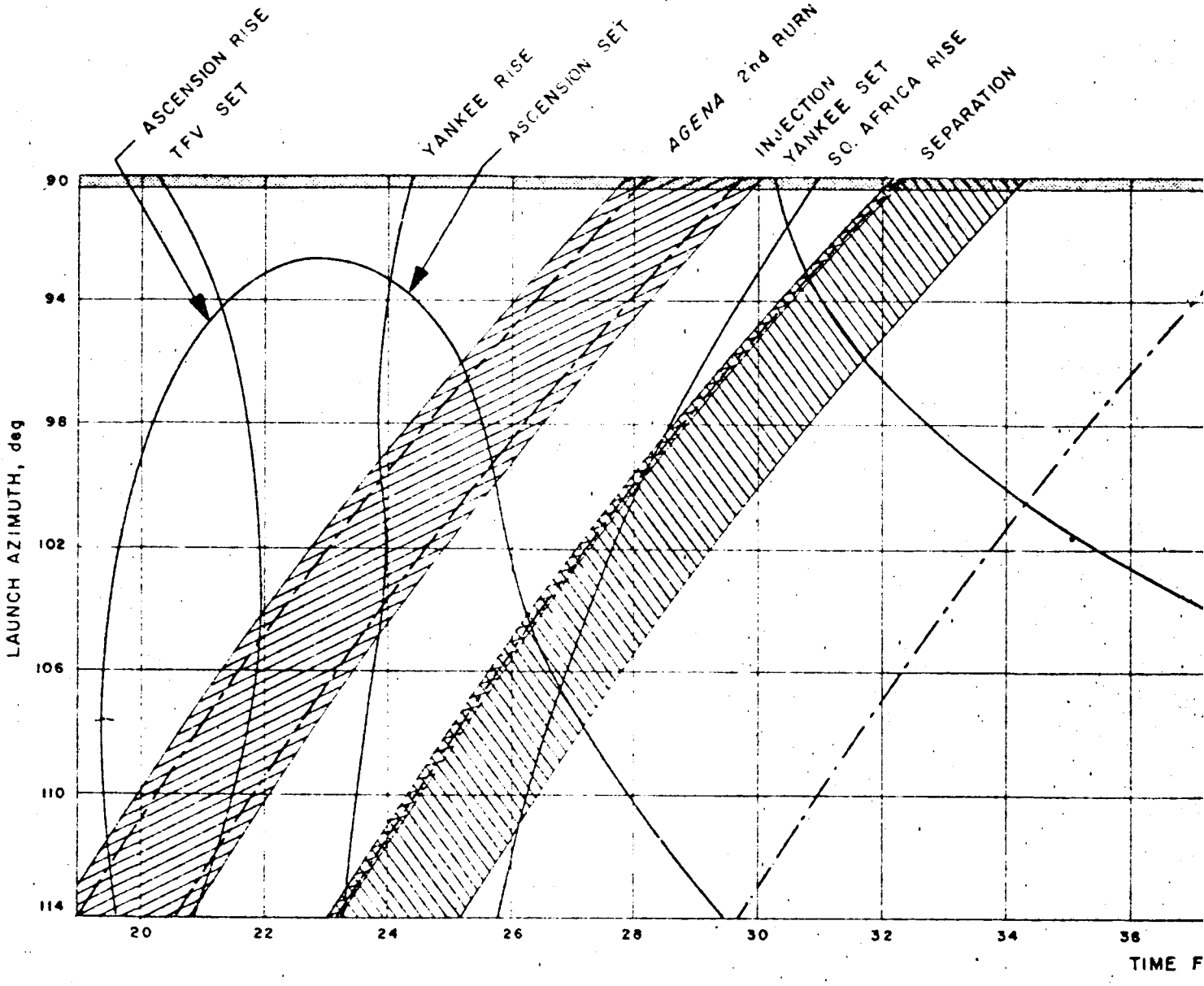
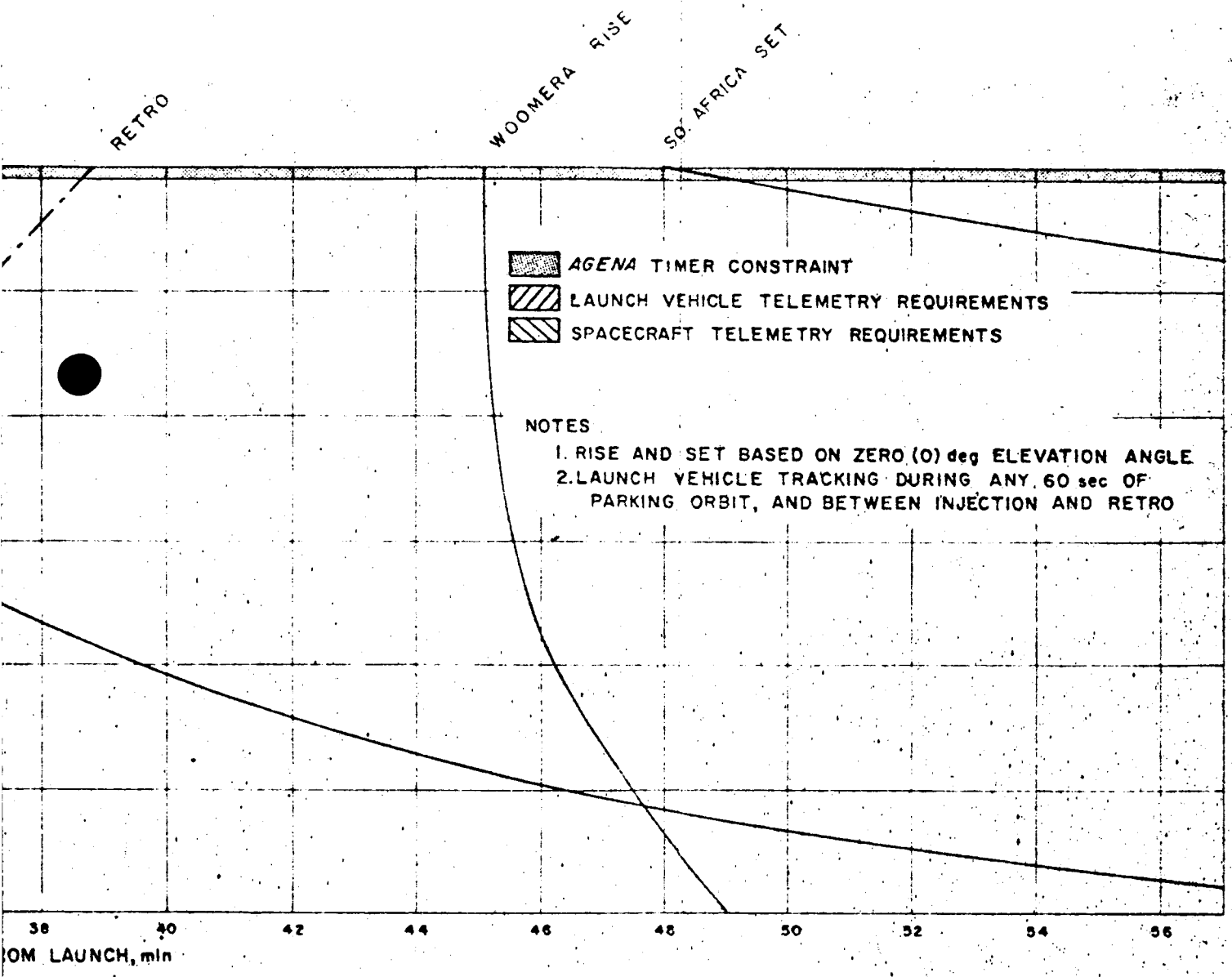
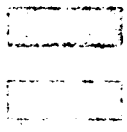


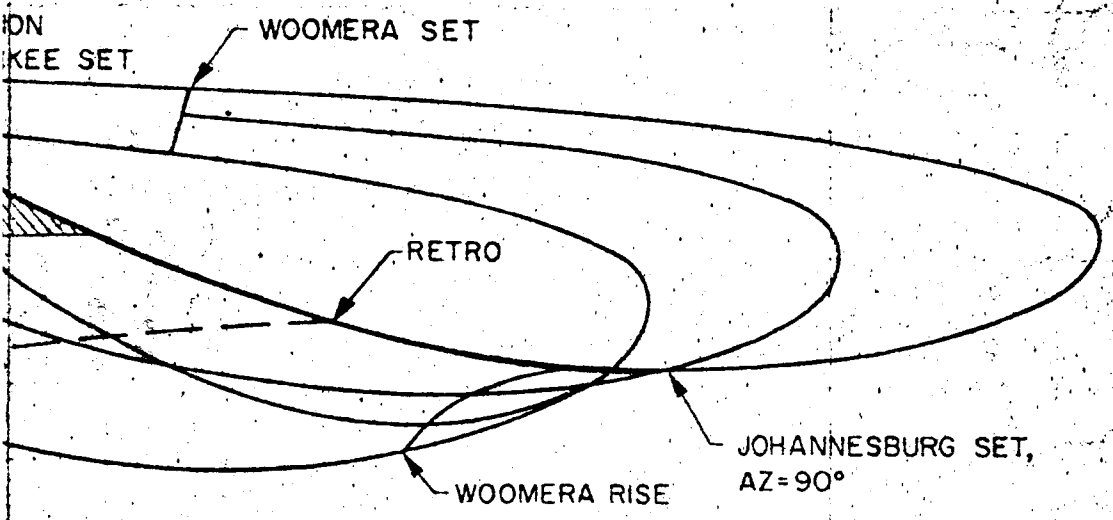
Fig. 4. AMR and DSIF station view p



riods for a launch on January 30, 1964



AGENA SECOND BURN



NOTES

1. RISE AND SET BASED ON ZERO (0) deg ELEVATION ANGLE
2. TRACKING REQUIRED DURING ANY 60 sec OF PARKING ORBIT, AND BETWEEN INJECTION AND RETRO
3. *AGENA* TIMER CONSTRAINT RESTRICTS THE EARLIEST POSSIBLE LAUNCH AZIMUTH TO 90.4 degrees

coverages for January 30, 1964

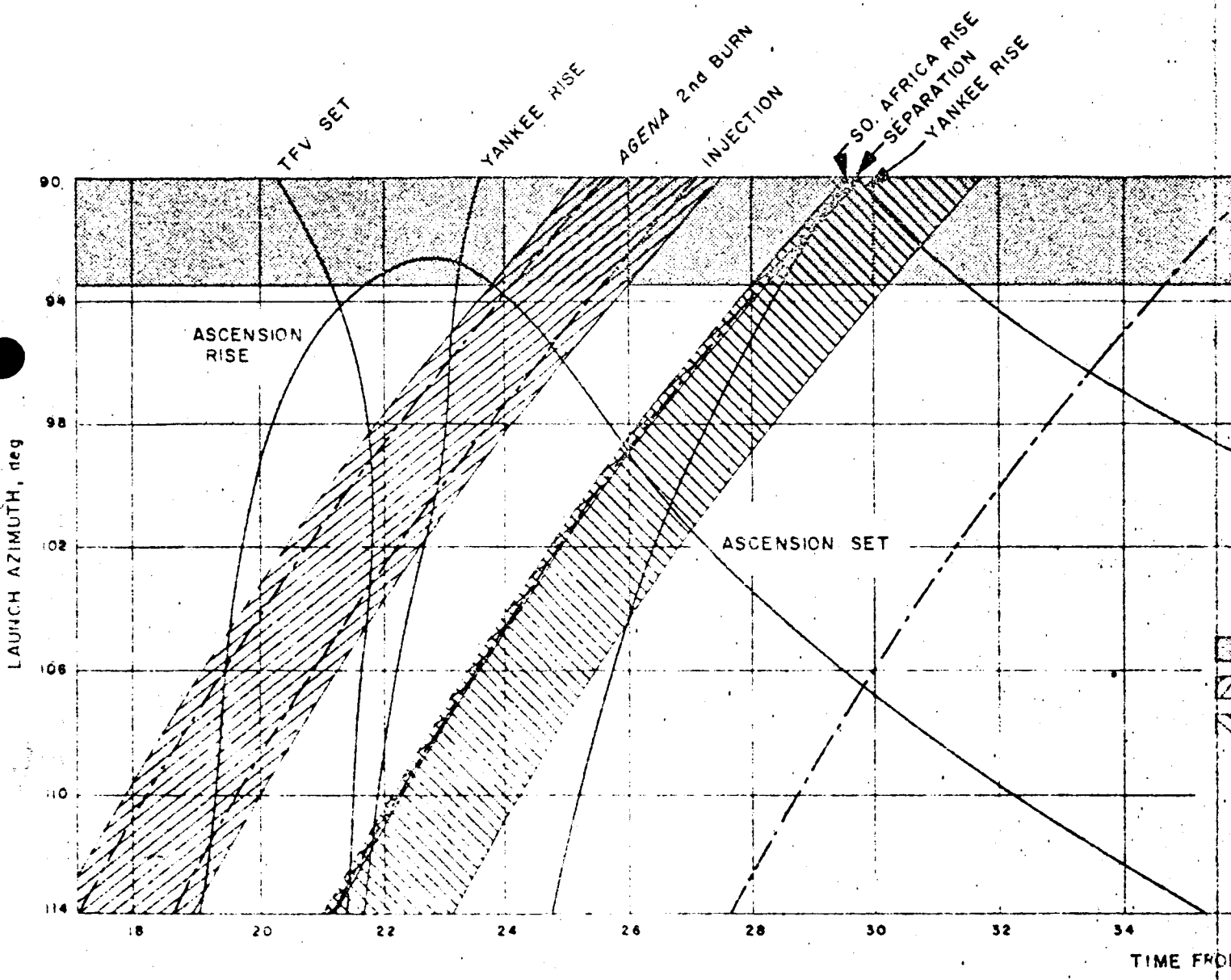
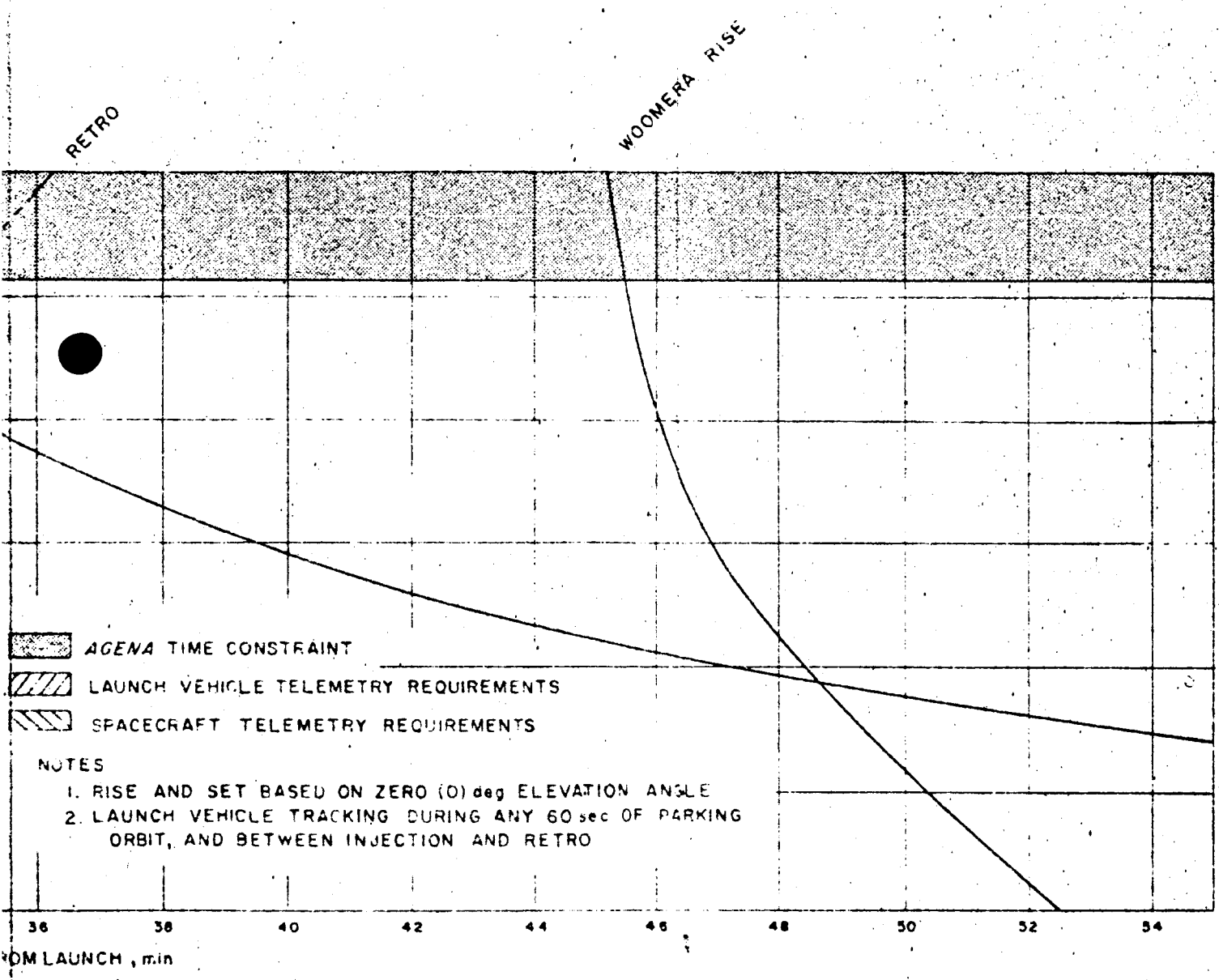


Fig. 6. AMR and DSIF station view peri



riods for a launch on January 31, 1964

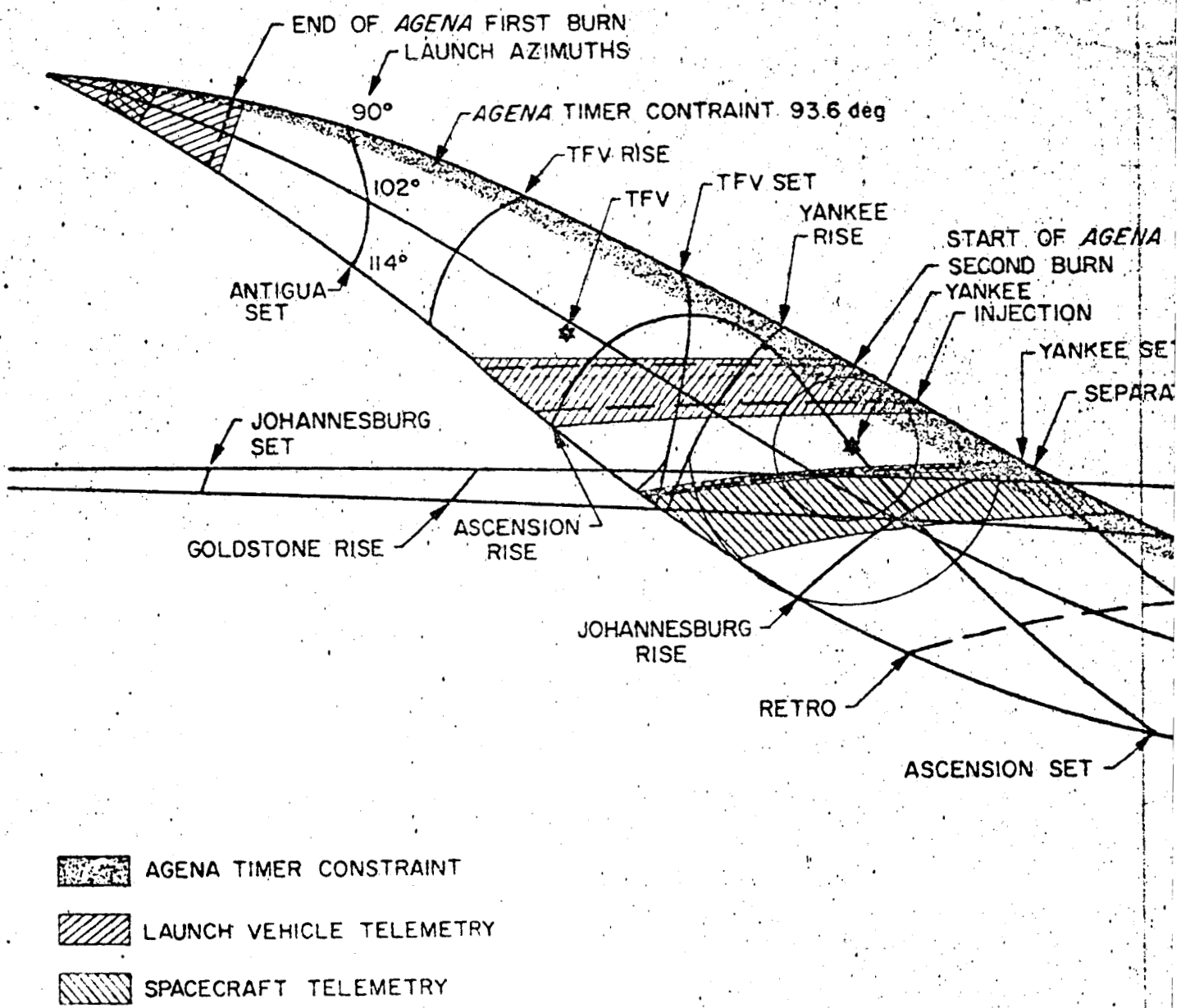


Fig. 7. Class I tracking and telemetry

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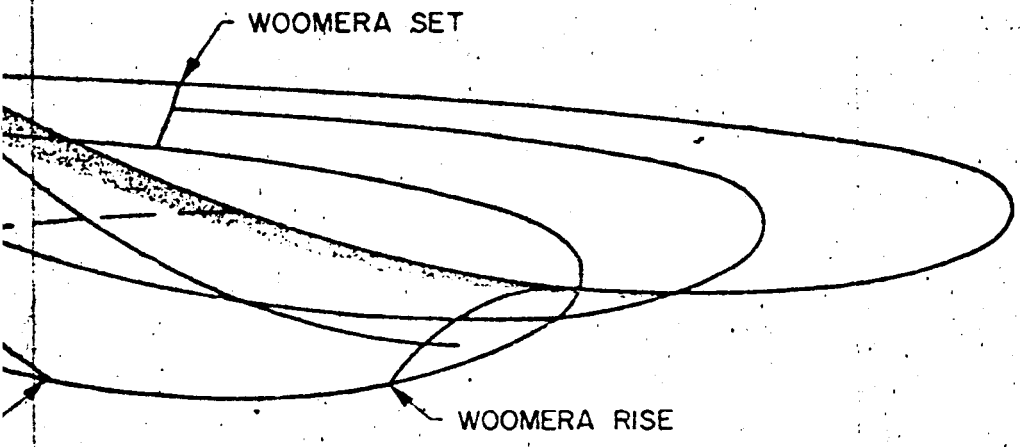
PARATION



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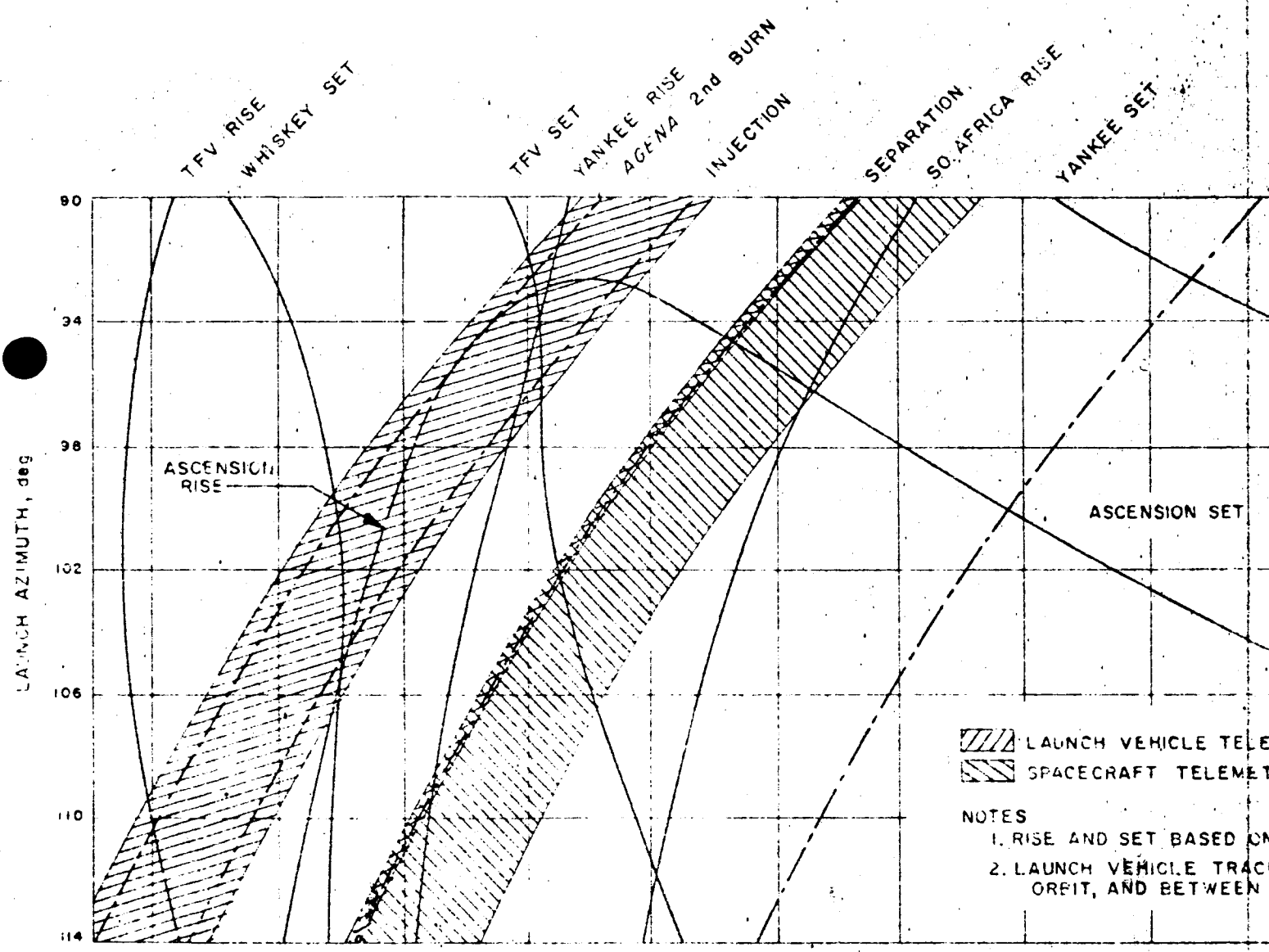
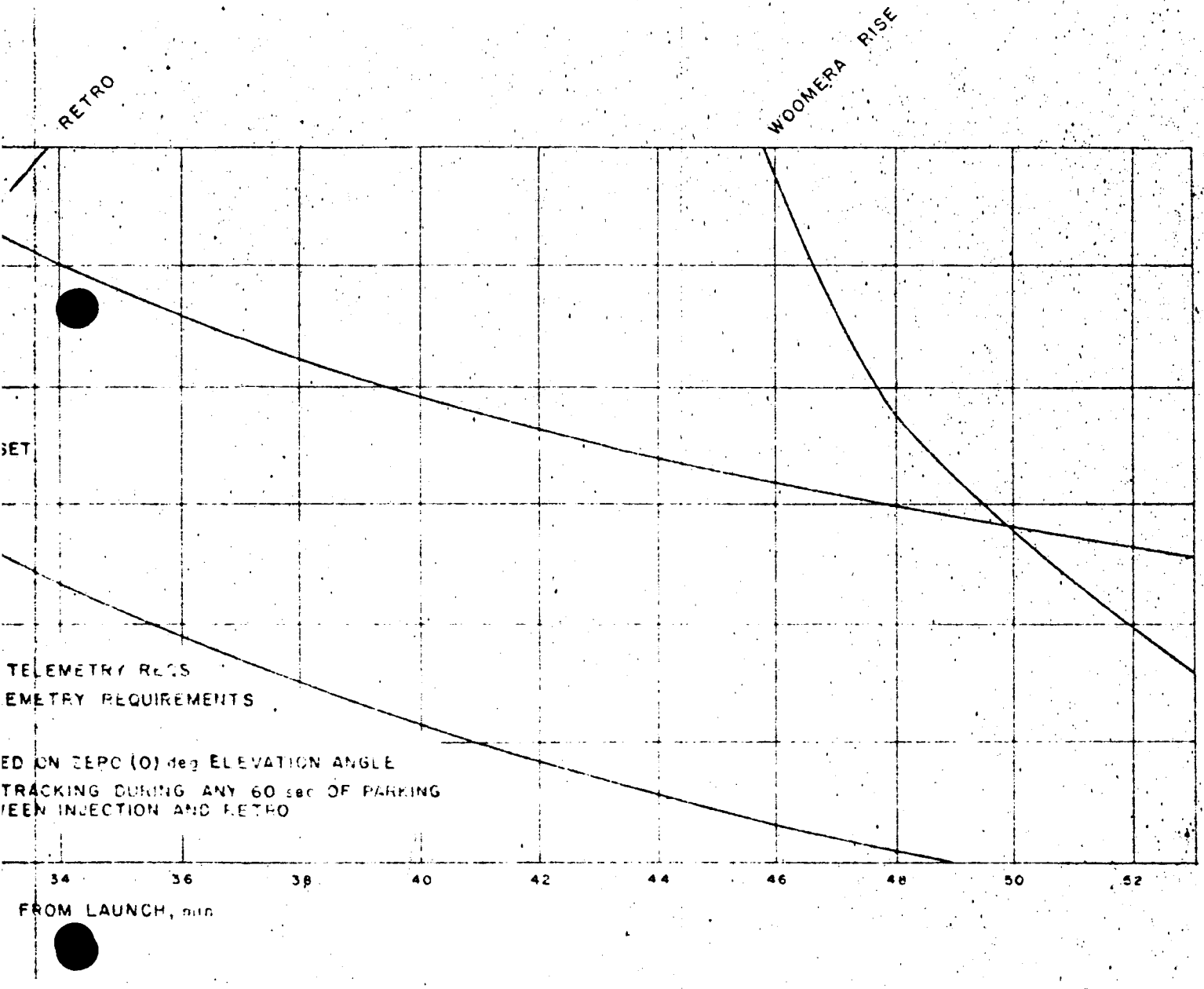


Fig. 8 AMR and DSIF station view perio



eriods for a launch on February 1, 1964

L-BAND COVERAGE

AGENA TELEMETRY

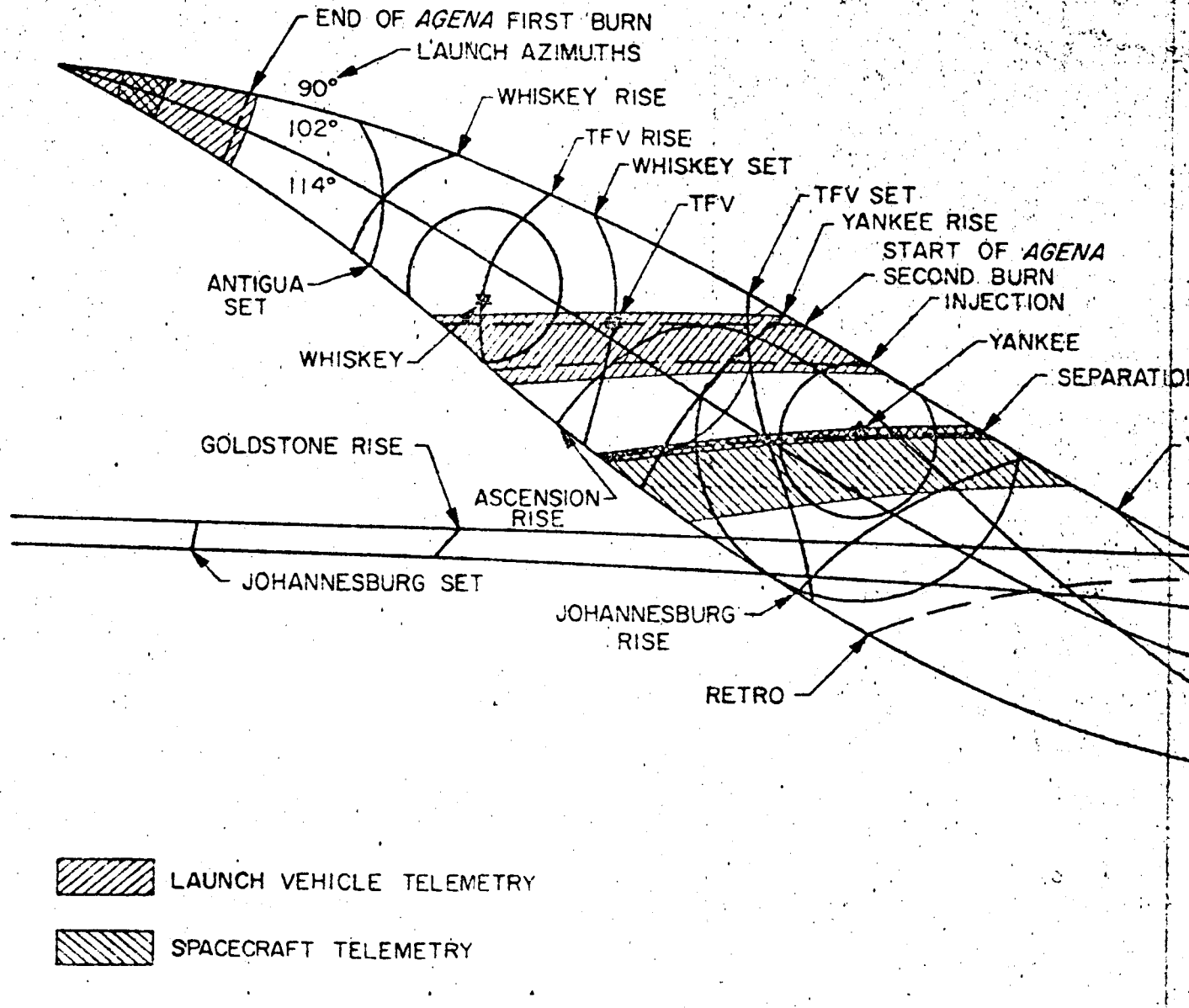


Fig. 9. Class I tracking and telemet

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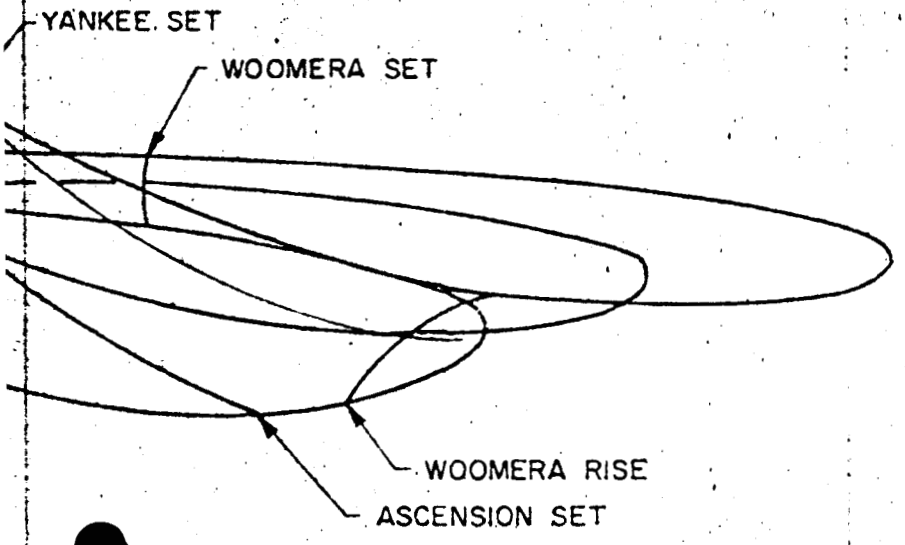

NOTES
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ntry coverages for February 1, 1964

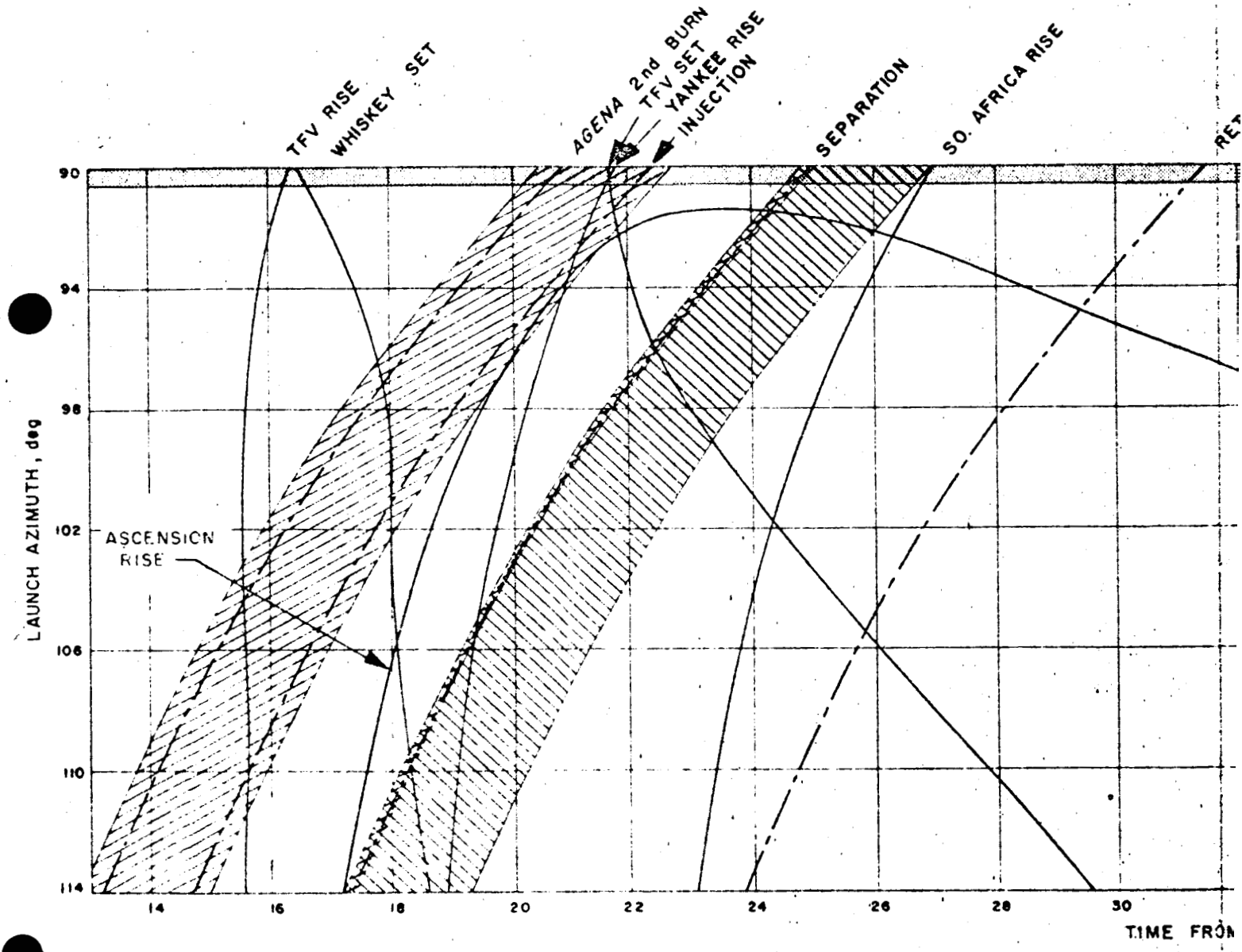
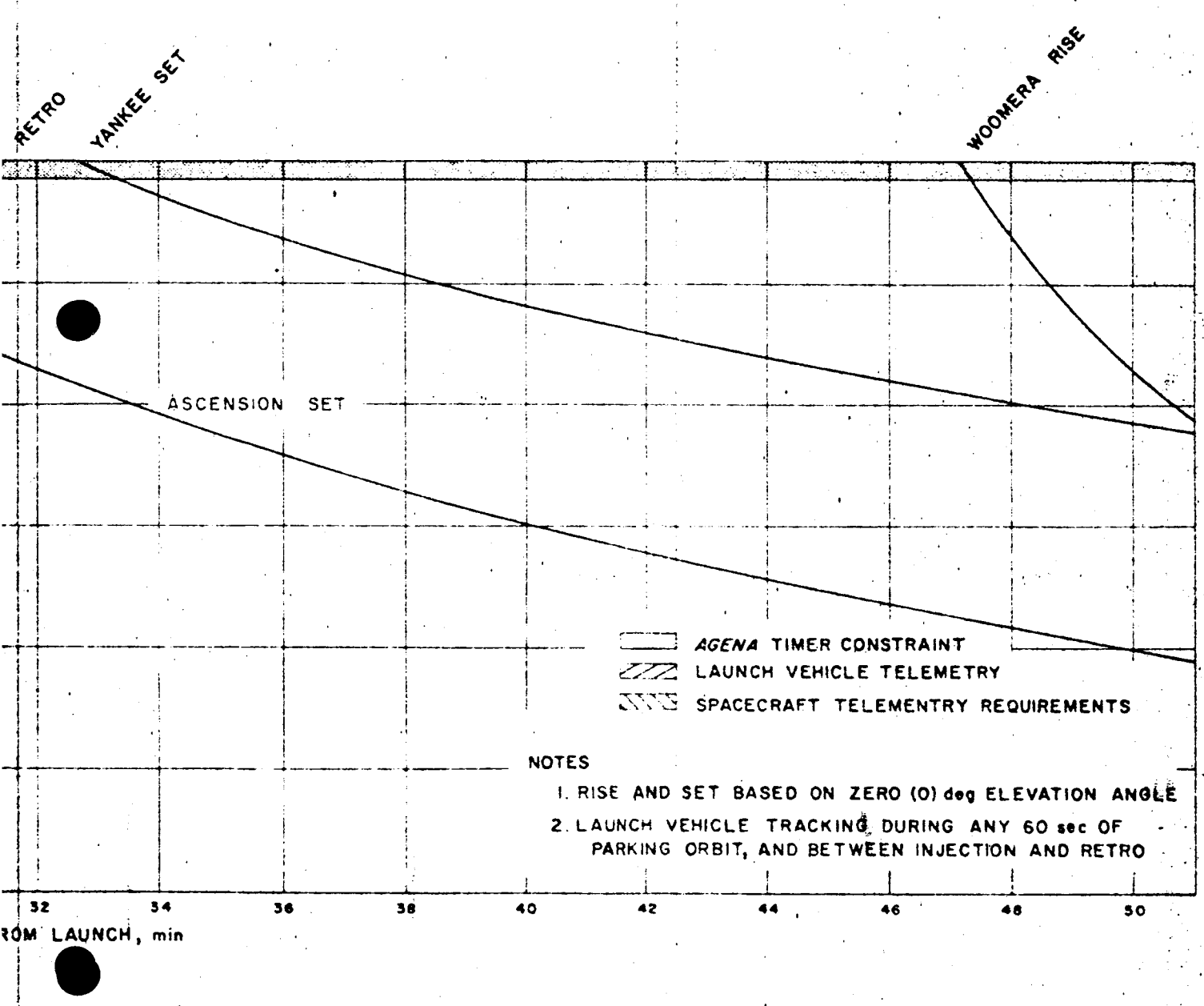
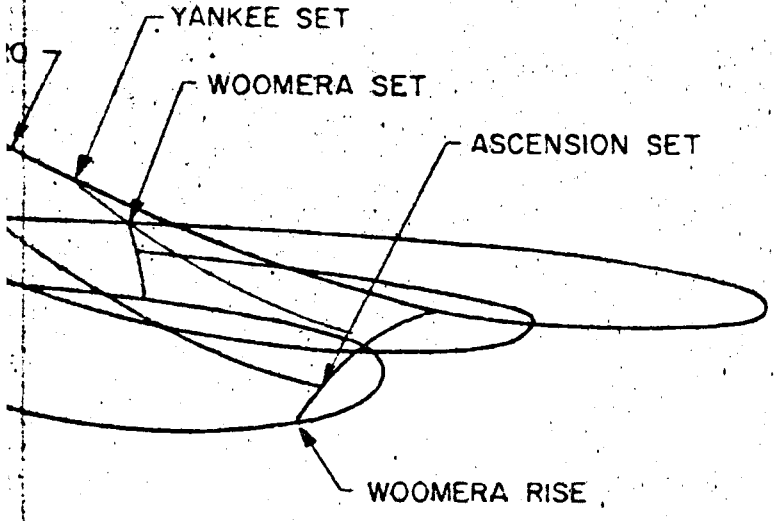


Fig. 10. AMR and DSIF station view pe



riods for a launch on February 2, 1964



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3. *AGENA* TIMER CONSTRAINT RESTRICTS THE EARLIEST POSSIBLE LAUNCH AZIMUTH TO 90.6 degrees

try coverages for February 2, 1964

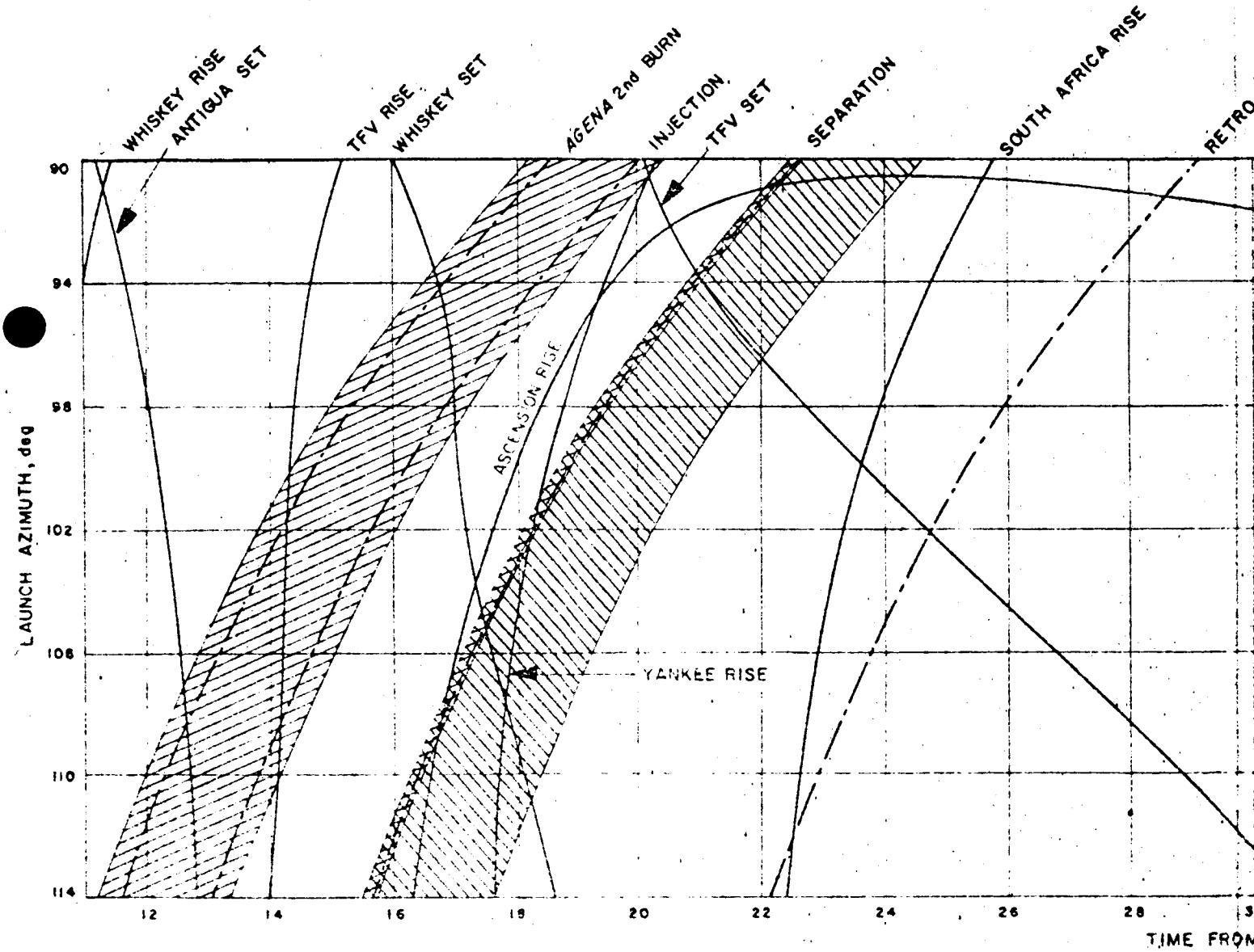
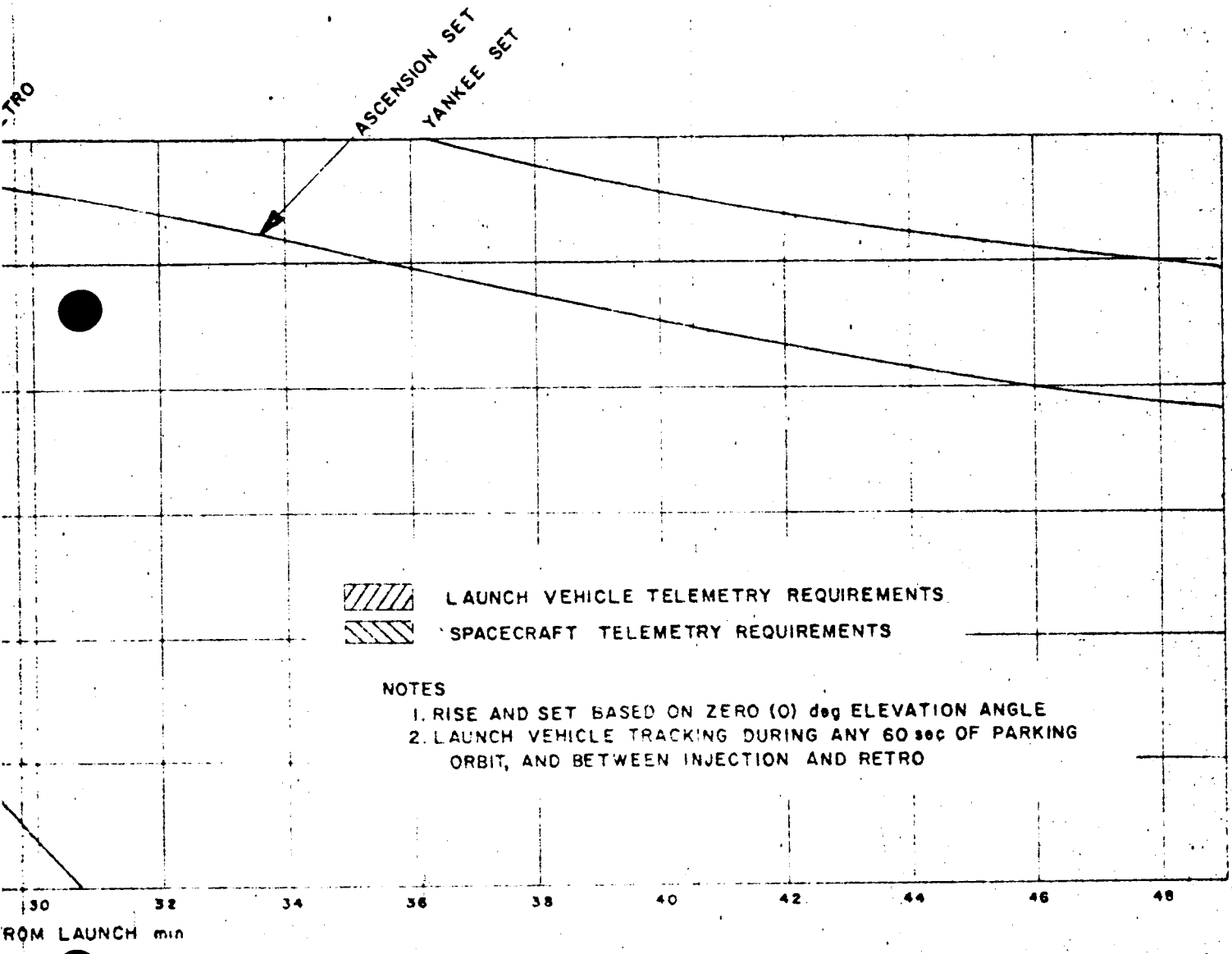
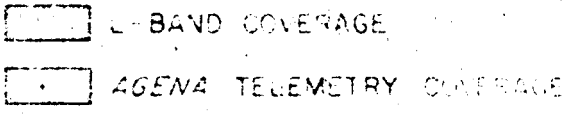


Fig. 12. AMR and DSIF station view pe



ds for a launch February 3, 1964


L-BAND COVERAGE
AGENA TELEMETRY COVERAGE

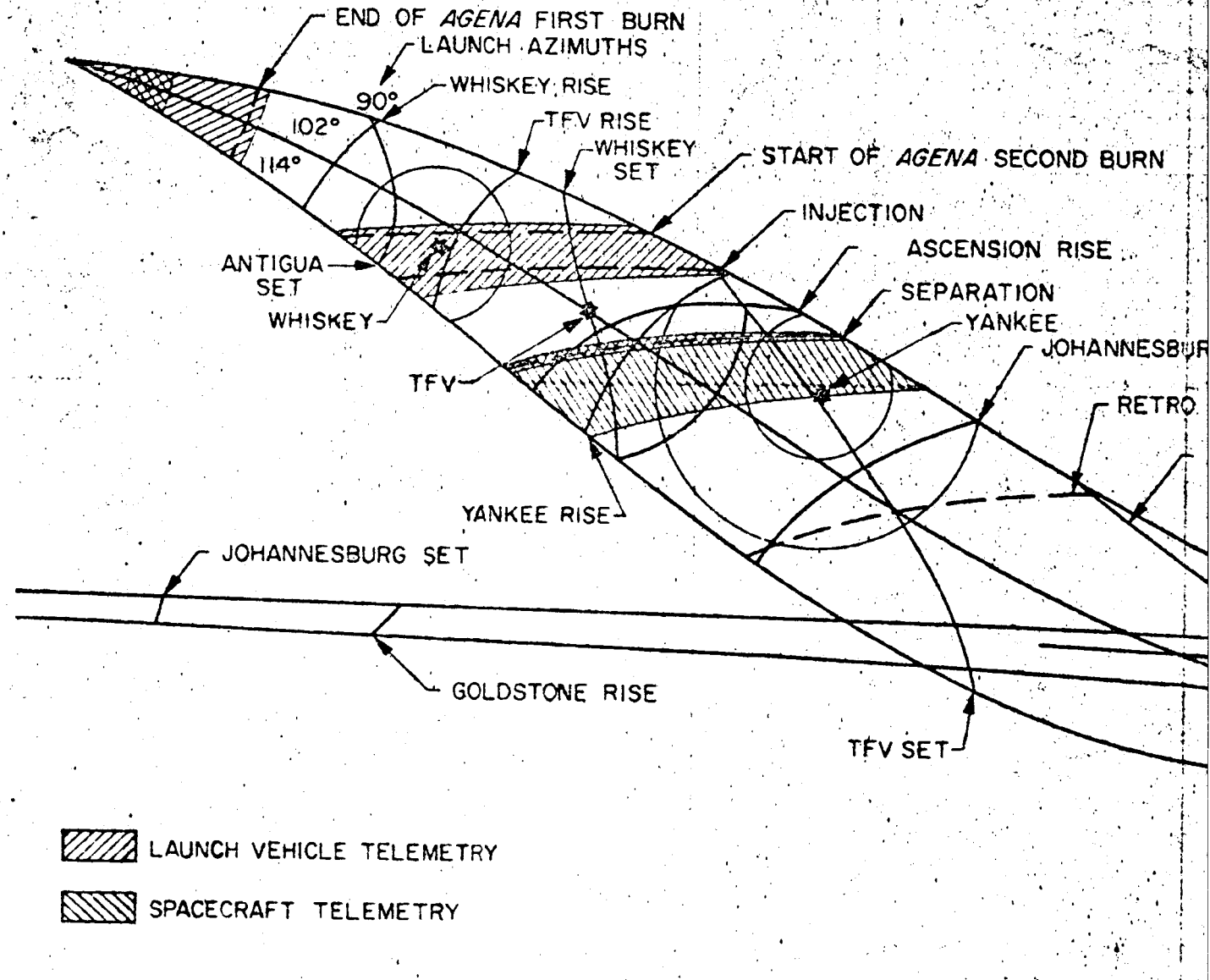


Fig. 13. Class I tracking and telemetry

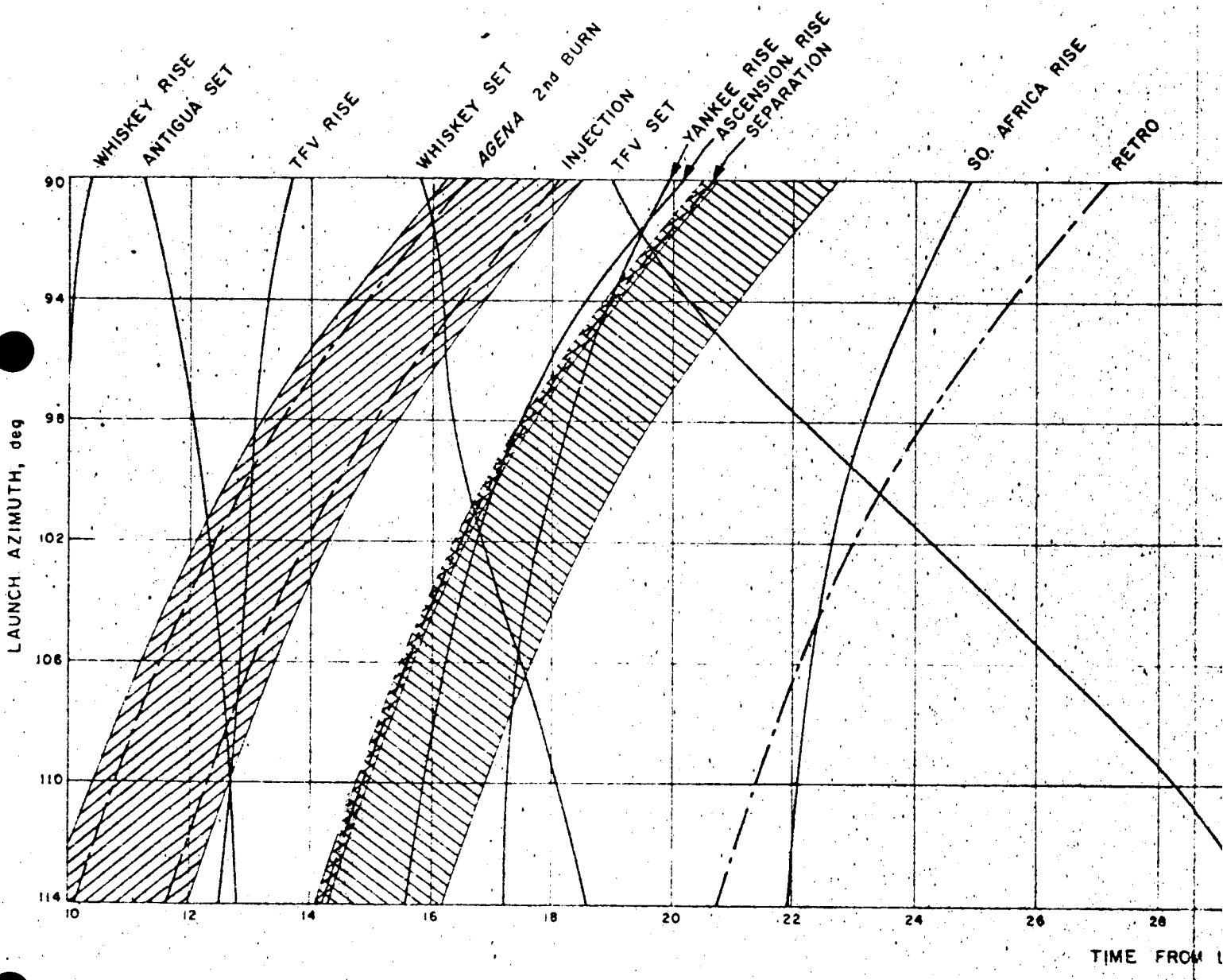
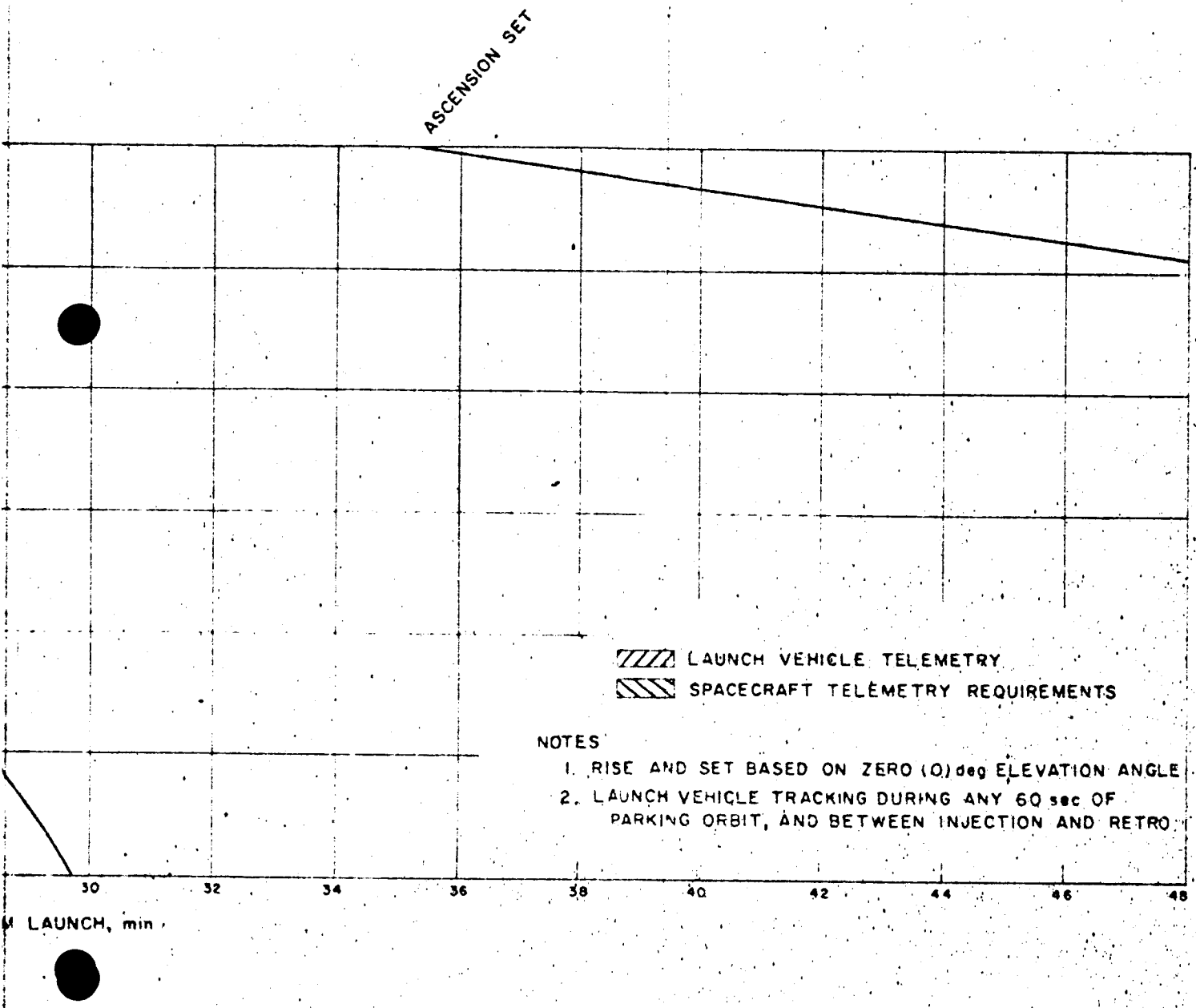


Fig. 14. AMR and DSIF station view per



ods for a launch on February 4, 1964

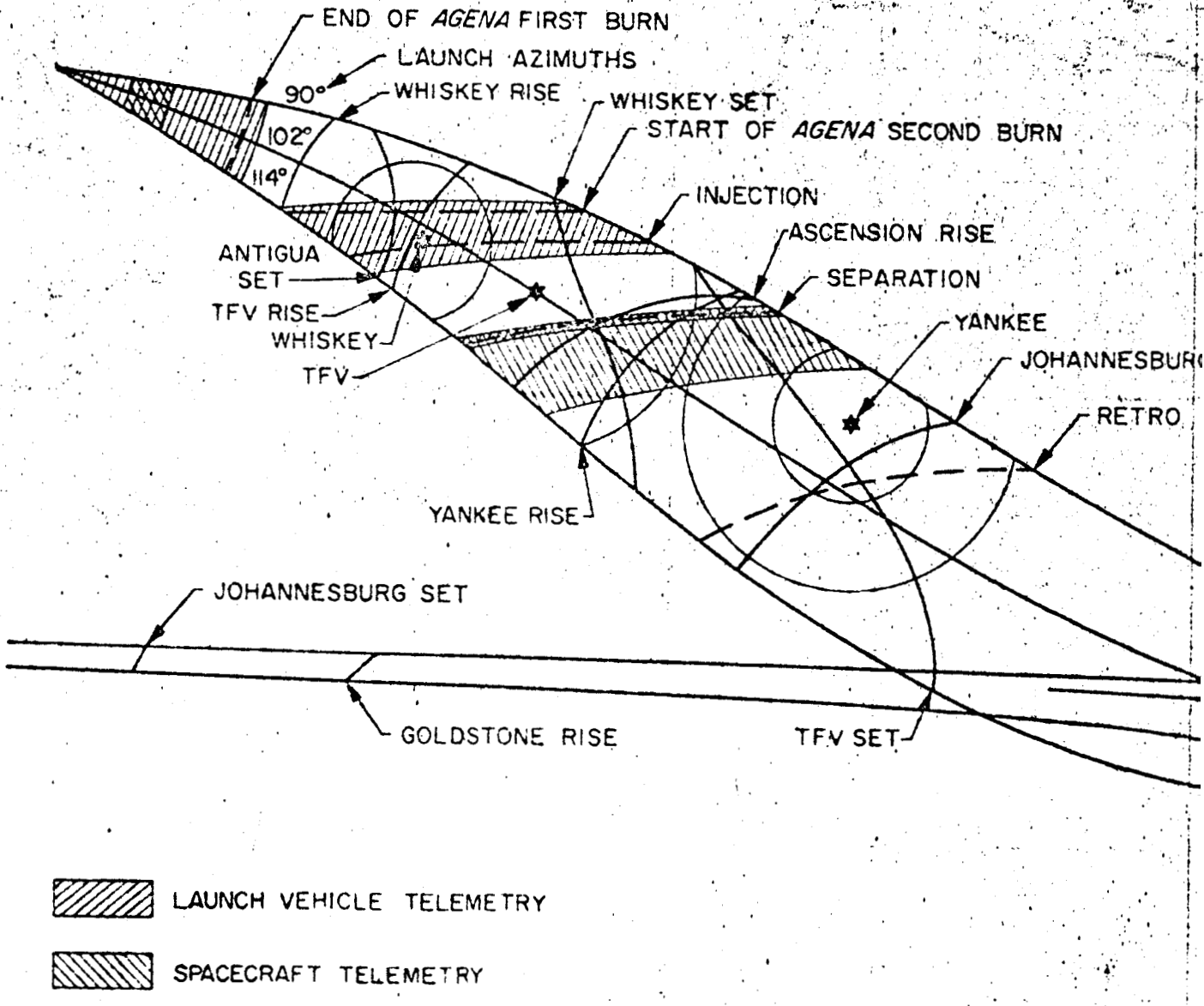
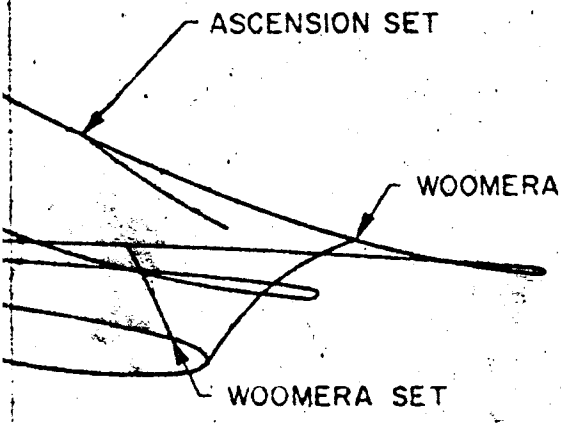


Fig. 15. Class I tracking and telemetry

G RISE



NOTES:
1. RISE AND SET BASED ON ZERO (0) deg ELEVATION ANGLE
2 TRACKING REQUIRED DURING ANY 60 sec OF PARKING ORBIT AND BETWEEN INJECTION AND RETRO

coverages for February 4, 1964

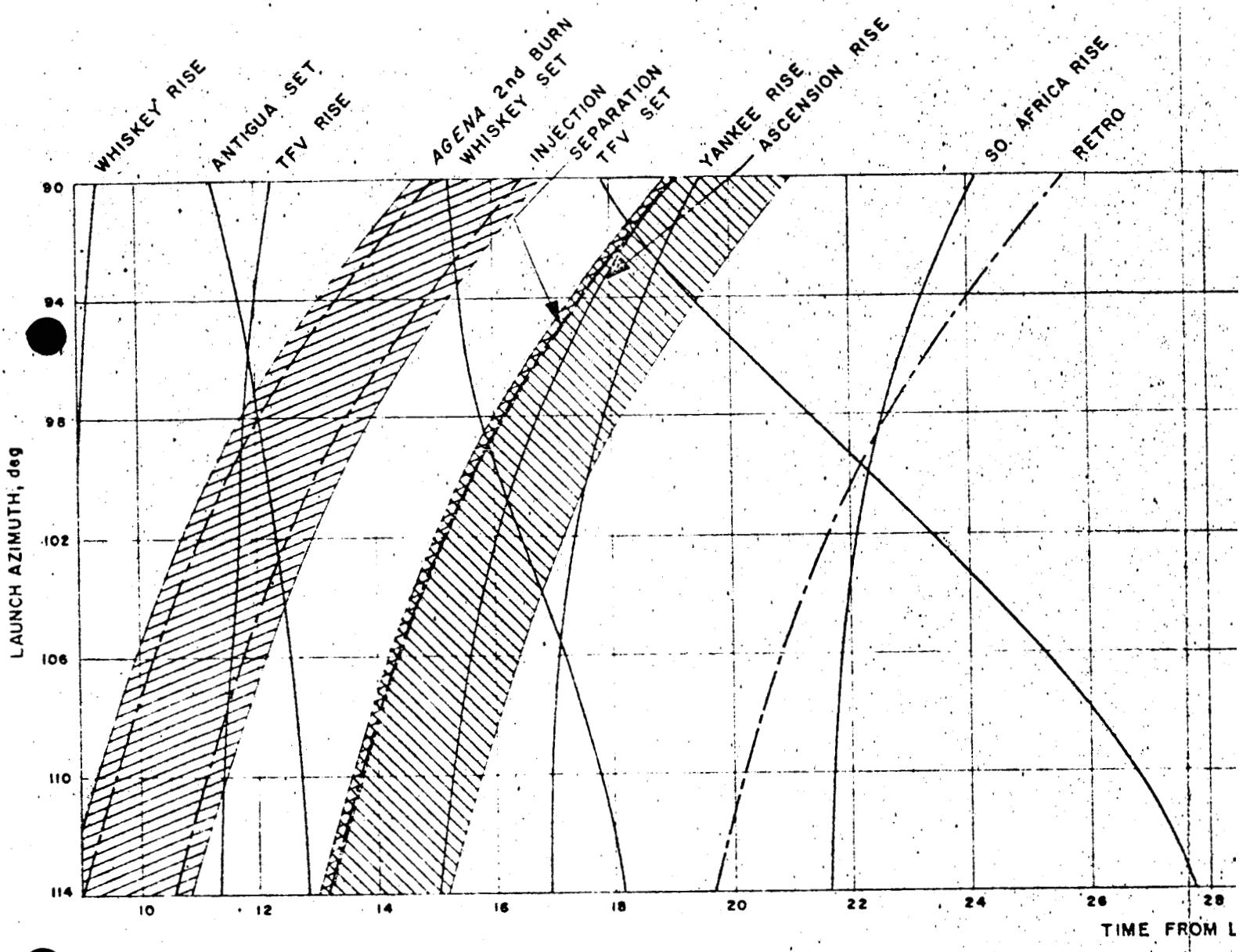
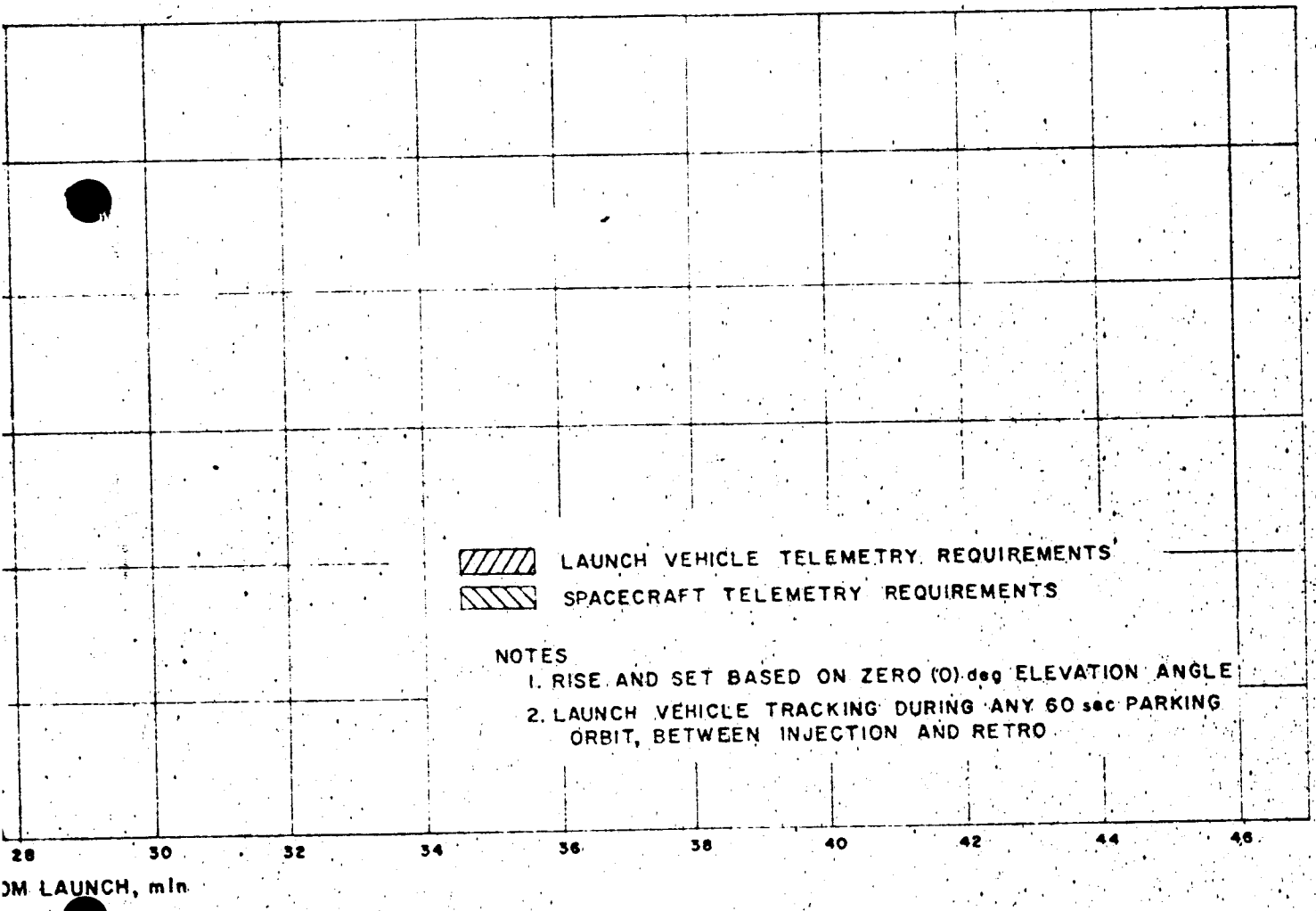
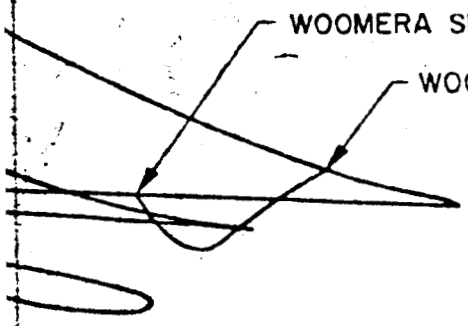


Fig. 16. AMR and DSIF station view periods



ods for a launch on February 5, 6, 1964



NOTES

1. RISE AND SET BASED ON ZERO (0) deg ELEVATION ANGLE
2. TRACKING REQUIRED DURING ANY 60 sec OF PARKING ORBIT, AND BETWEEN INJECTION AND RETRO